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Research Article

Plyometric Exercise with Dynamic and Kinesio Taping for Football Players

Combined Effects of Plyometric Exercise with Dynamic Taping and Kinesio Taping On Muscle Power, Speed, And Muscle Strength Among University Male Football Players – A Randomized Controlled Trial

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Abstract: Plyometric exercise (PE) is a high-intensity, short-duration training method that may offer an adequate stimulus to improve physical fitness and sport-specific performance. The sports medicine team employs KT tapes in isolation or in conjunction with workout regimens to enhance athletic performance. Research has been done to find out the combined effects of plyometrics with various elements to improve sport-specific fitness performance among football players. More research needs to be examining the collective impact of plyometrics in conjunction with taping on fitness performances. The present randomized controlled trial study aims to determine the combined effect of plyometrics with dynamic taping (DT) and kinesio taping (KT) to improve muscle power, speed, and muscle strength among university football players. Forty-five university male football players between 18 and 25 who fulfilled the inclusion criteria were randomly assigned to 1 of 3 groups (DT, KT, and control groups). Athletes performed PE for 6-weeks. Outcomes were measured at baseline and six weeks post-PE. Vertical jump, standing long jump, and single leg hop tests were used to measure muscle power, and the 30-meter sprint and strength dynamometers were used to measure speed and muscle strength, respectively. Significant differences were found in the group receiving PE and DT than the other groups in all the outcome variables (p<0.05). The combined effects of PE and DT significantly affect muscle power, speed, and muscle strength among university male football players compared to KT with PE and PE alone.

Keywords: Plyometric exercise, Dynamic tape, Kinesio tape, muscle power, speed, muscle strength, and university football players

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1. INTRODUCTION

Plyometric exercise is a high-intensity, short-duration training method that may offer an adequate stimulus to improve physical fitness and sport-specific performance.[1-3] Fast stretch-shortening muscle contractions are used in the exercise, which allows for stronger concentric work performance than isolated concentric muscle contractions and stimulates rapid force production and force absorption muscular capacities.[4] Football is a team invasion game involving high-intensity exertion performed intermittently, requiring various athletic abilities (i.e., power, strength, endurance, agility, speed).[5] Plyometric training is acknowledged as a safe and effective way to increase explosive actions. It should be a significant part of football players' fitness regimens since it is crucial to many team sports.[6] A musculoskeletal physiotherapist in Australia named Ryan Kendrick created the dynamic taping (DT) method in 2009. It is a relatively new treatment procedure that is increasingly used as an additional approach to address musculoskeletal issues. DT comprises a visco-elastic nylon and lycra blend material that can stretch and recoil in four directions (longitudinal and transverse). It has no hard terminus, a significant degree of stretch (greater than 200%), and viscoelastic characteristics. DT's primary method of action is mechanical (deceleration of eccentric work, load absorption, and help of movement), while the secondary mode of action is neurophysiological. The tape is placed in a shortened position of the joint.[7] A Japanese chiropractor, Kenzo Kase, invented Kinesio Tape (KT) in 1973. It is used to apply elastic taping to the skin of patients under tension. The tape has a similar thickness to normal tape and may be longitudinally extended up to 140% of its original length, resulting in less mechanical restraint and less movement restriction. KT generally adjusts misaligned joints, bolsters muscles, turns on the endogenous analgesic system and drains congested fluids.[8] Football is an endurance sport that incorporates 90 minutes of periods of intensive effort alternating with periods of slower-paced action.[9] Football's execution and level have improved recently, which has prompted sports scientists and trainers to consider and identify several avenues for future performance advancement. Muscle power,[10] muscle strength,[11] and speed,[12] are very important fitness components in athletic performance in football. The most recent research offers numerous possibilities for enhancing football performances, including taping,[13] pre-cooling,[14] diet and nutrition,[15] sports drinks,[16] psychological therapies,[17] plyometric exercises, and [18]. Plyometrics involve an eccentric contraction of the musculotendinous unit followed immediately by a concentric contraction (termed the stretch–shortening cycle (SSC)). The SSC increases the musculotendinous unit's capacity to generate the most force in the shortest amount of time.[19] In invasion games, plyometric training should comprise most fitness regimens because it is considered secure and effective for enhancing explosive movements.[20] Similar to plyometrics, taping is one of the most popular and widely utilized techniques for enhancing athletes' performance.[21] A comprehensive review by Kons et al. included twenty-nine meta-analyses and concluded that plyometrics is useful for enhancing sport-specific fitness markers.[22] Additionally, the researchers combined plyometrics with different surfaces,[23] balance exercises,[24] Pilates,[25] resistance training,[26] cyclings,[27] neuromuscular electrical stimulation,[28] isometrics,[29] agility,[30] strengthening exercises,[31] whole-body vibrations,[32] Asanas,[33] and eccentric exercises,[34] for the improvement of on-field performances. Thus, we hypothesized that the combined effect of plyometrics and DT is better than KT and no tape to improve sport-specific fitness parameters. However, no research has evaluated the combined effect of plyometrics with taping. Thus, the present study aims to determine the combined effect of plyometrics and DT to improve sport-specific fitness parameters.

2. MATERIALS AND METHODS

2.1. Study design and setting

The present study employed a monocentric, randomized, controlled design to evaluate the combined effect of plyometric exercise with dynamic training (DT) in comparison to Kinesio taping (KT) in enhancing muscle power, muscle strength, and speed among university football players. The study was conducted at the university playground of King Khalid University, situated in Saudi Arabia. The study was approved by the Institutional Review Board at King Khalid University, Saudi Arabia (ECM#2020-3208).

2.2. Study population

Male football players from the university were chosen based on their eligibility. The study included male football players aged 18 to 25 who were healthy and free from injuries.

2.3. Inclusion criteria

Football players with a minimum of 4 years of playing experience and ensuring that all participants had a similar level of expertise. Furthermore, all participants got identical training in type, frequency, and intensity.

2.4. Exclusion criteria

The exclusion criteria encompassed a six-month history of injuries, any existing injury that could impact performance, a history of surgical procedures, back problems, and allergies to adhesive materials. After the initial assessment, participants were assigned to different groups using a randomization process provided by the website http://randomizer.org/ (Social Psychology Network, Connecticut, USA). The groups included the DT group (n = 15), KT group (n = 15), and control group (n = 15). Concealed allocation was performed using a computer-generated block randomized table of numbers (1 for the DT group, 2 for the KT group, and 3 for the control group) created before data collection. Subsequently, the random numerical sequence was enclosed within sealed opaque envelopes. Unaware of the first examination results, the researcher unsealed an envelope and carried out the treatment as per the assigned group. A blinded independent assessor, unaware of the study's hypothesis and methods, evaluated the outcome measures before and after the intervention for the treatment group. Figure 1 presents a flow chart illustrating the sequence of participants involved in the selection, follow-up, and analysis stages.

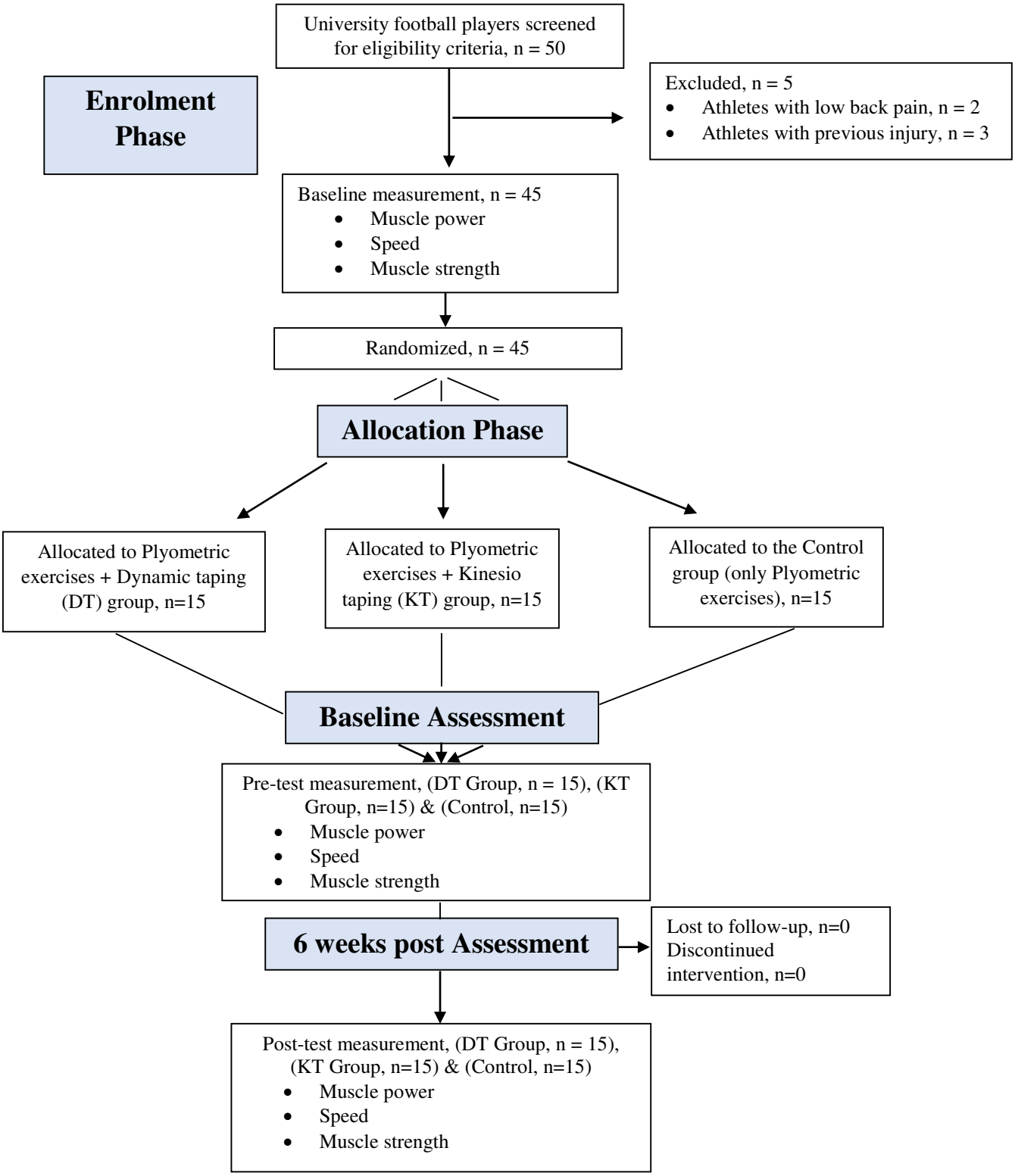


Fig 1: Study flow diagram

2.5. Outcome measures

The initial assessment encompassed collecting demographic data, medical background, and a comprehensive physical examination. The athletes' demographics included many variables, such as the age of the patients, their body weight measured in kilograms, height measured in centimeters, and body mass index calculated as the ratio of weight in kilograms to the square of height in meters. Additionally, the data included information on the athletes' education level, years of professional experience, hours of training, smoking status, and engagement in regular exercise. The outcome measures were muscle power, speed, and muscle strength. Muscle power was evaluated by implementing the vertical jump test, standing long jump test, and single leg hop test.[35] The average of the three trials was computed to determine the overall assessment. The single-leg hop test was conducted using the dominant leg. The velocity of the athlete was assessed utilizing the 30-meter sprint test. This test aims to assess both acceleration and speed while also evaluating the efficacy of athletes' sprint training.[36] The participants engaged in two trials, and the most optimal time was utilized for the evaluation. The evaluation of muscle strength involved the utilization of a portable dynamometer to measure the strength of the quadriceps muscles.[37] Every fitness test was conducted following the required warm-up activities, which included running and stretching. A duration of fifteen minutes is allocated for rest between each component of physical fitness. Appropriate

measures were implemented to ensure the prevention of injuries during the testing process.

2.6. *Intervention*

Following the initial assessment, the study participants were subjected to applying a piece of DT on the right-side forearm and KT on the left-side forearm. The absence of an allergic reaction was confirmed during a 24-hour period of tape application. Participants who exhibited signs of an allergic reaction were eliminated from the study. Following completing the baseline assessment, the participants were assigned to three groups (DT, KT, and Control) using a random allocation method. Before the application of tape, the skin surface was prepped through the process of shaving. Both the DT and the KT were consistently employed in a standardized manner, starting from the origin and moving towards the insertion of the Quadriceps muscle. This process was initiated from a specific position located 10 cm below the anterior superior iliac spine (ASIS). A 7.5 cm wide dynamic tape (DT) was applied with light tension to the point of resistance. The application was performed while the athlete was in a sitting posture with the knee fully extended, starting from a location 10 cm below the anterior superior iliac spine (ASIS). The tape was placed along the anterior thigh, over the knee joint, and finished about two-thirds down the length of the tibia on both sides.[7] (Figure 2).

Fig 2: Dynamic taping

A KT measuring 5 cm in length was placed from a location 10 cm below the ASIS to the patella's superior pole with no stress application. Subsequently, the athlete was instructed to execute a knee extension movement to the maximum extent possible. The Kinesio Tape (KT) was then applied, with separate sections allocated for the medial and lateral borders of the patella, terminating at the anterior tuberosity of the tibia, ensuring a taut-free application.[8] (Figure 3).

Fig 3: Kinesio taping

2.7. *Plyometric Training*

Following the implementation of DT and KT, the study participants engaged in a plyometric exercise session for six weeks. The intervention was conducted within the context of the competitive season. The participants adhered to their normal soccer training regimen while maintaining their weekly competitive schedule. The plyometric training sessions were conducted twice a week, specifically on Mondays and Thursdays, immediately following the initial warm-up. This sequencing was implemented to optimize the potential gains players could derive from the program.[38] Details of the plyometric training are presented in Table 1.

Table 1. Plyometric training program

Type of Exercises	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Drop Jumps (DJ)	2 X 4*	2 X 5	2 X 6	2 X 7	2 X 8	2 X 6
Countermovement jumps with arms (CMJA)	2 X 4	2 X 5	2 X 6	2 X 7	2 X 8	2 X 6
Horizontal countermovement jumps with arms (HCMJA)	2 X 4	2 X 5	2 X 6	2 X 7	2 X 8	2 X 6
Right-leg horizontal countermovement jumps with arms (HCMJA-Right)	2 X 4	2 X 5	2 X 6	2 X 7	2 X 8	2 X 6
Left-leg horizontal countermovement jumps with arms (HCMJA-Left)	2 X 4	2 X 5	2 X 6	2 X 7	2 X 8	2 X 6
180^0 jumps	2 X 4	2 X 5	2 X 6	2 X 7	2 X 8	2 X 6
Alternate leg bounds	2 X 4	2 X 5	2 X 6	2 X 7	2 X 8	2 X 6

: 2 × 4 indicates 2 sets of 4 repetitions each

The inter-set recovery period was similarly used for the inter-jump exercises, with a total of 13 recovery intervals incorporated in each training session. The study employed a low-intensity, active-recovery inter-set procedure.

2.8. Drop jumps

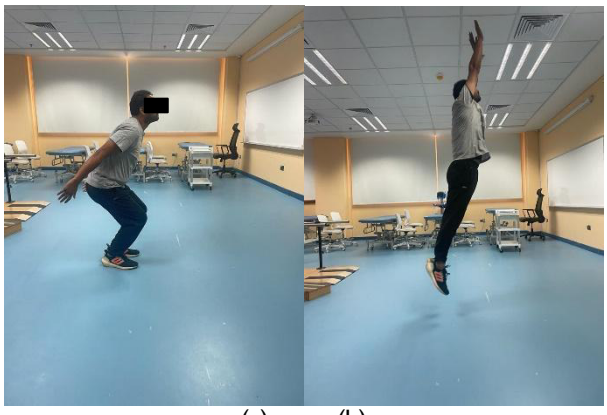
The drop jump is characterized by falling off a box and rebounding with quick ground contact times and minimal knee bending, focusing on muscular and tendon stiffness.

(a) (b) (c)

Fig 4 (a, b, & c): Plyometric exercises – Drop jump.

2.9. Countermovement jumps with arms (CMJA)

A vertical jump is performed by having an athlete quickly squat to a self-selected depth and then jump as high as possible vertically upwards.



(a) (b)

Fig 5 (a & b): Plyometric exercises - Countermovement jump with arms (CMJA)

2.10. Horizontal countermovement jumps with arms (HCMJA)

A horizontal jump is performed by having an athlete quickly squat to a self-selected depth and then jump as forward as possible horizontally.

(a) (b) (c)

Fig 6 (a, b, and c): Plyometric exercises – Horizontal countermovement jump with arms.

2.11. Right-leg horizontal countermovement jumps with arms (HCMJA-Right)

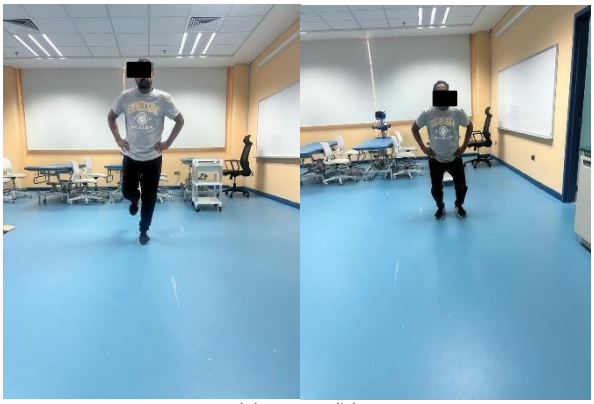
A horizontal jump is performed by having an athlete quickly squat to a self-selected depth using the right leg, then jump as far forward as possible horizontally and land with the double leg.

(a) (b)

Figure 7 (a & b): Plyometric exercises - Right-leg horizontal countermovement jumps with arms (HCMJA-Right)

2.12. Left-leg horizontal countermovement jumps with arms (HCMJA-Left:

A horizontal jump is performed by having an athlete quickly squat to a self-selected depth using the left leg, then jump as far forward as possible horizontally and land with the double leg.

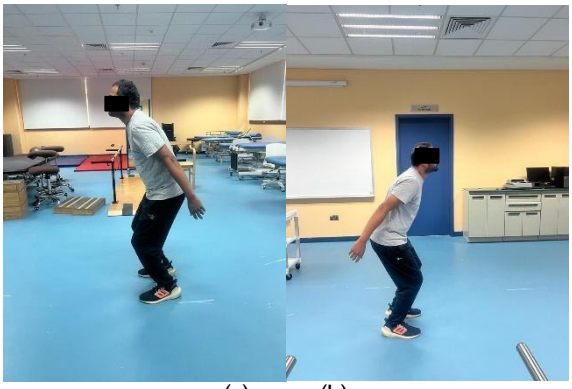


(a) (b)

Fig 8 (a & b): Plyometric exercises - Left-leg horizontal countermovement jumps with arms (HCMJA-Left)

2.13. 180^0 jumps

Explosively jump quickly from squat to a self-selected depth, extend the arms overhead (shoulder flexion), turn 180 degrees in the opposite direction in mid-air, and land with both legs.

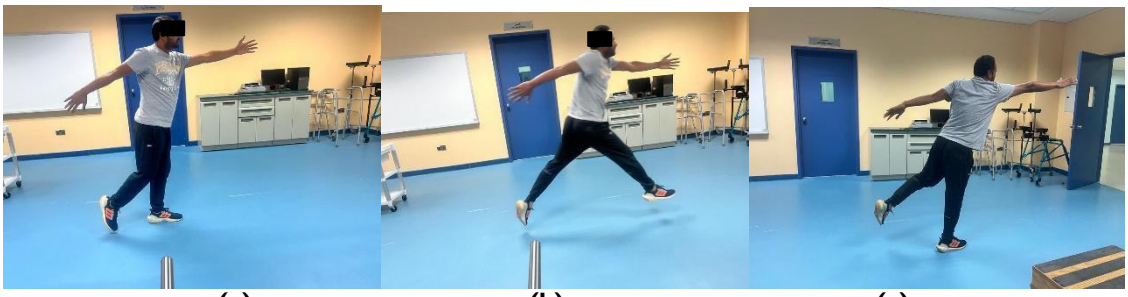


(a) (b)

Figure 9 (a & b): Plyometric exercises – 180^0 jump

2.14. *Alternate leg bounds*

Start with one foot in front of the other, push off with the front leg as much force as possible, drive the opposite knee up and forward, and land with the front foot. Then, repeat with the opposite leg and push with as much force as possible, covering as much distance as possible.



(a) (b) (c)

Fig 10 (a, b, & c): Plyometric exercises – Alternate leg bounds

The drop jump drill was executed with the arms positioned on the hips and the elbows externally rotated, whereas the remaining jump drills were executed with an arm swing. Participants were instructed to exert their utmost effort to attain maximum performance, namely in height and distance. During drop jumps, participants were provided with instructions to limit the duration of ground contact time, specifically aiming for a value below 250 milliseconds. Additionally, they were encouraged to maximize the ratio between the achieved vertical height and the duration of ground contact time. Participants were assigned box heights ranging from 5 to 40 centimeters to provide personalized training.[38] To introduce diversity into the training regimen, the sequence of drills was varied every week.[39] In all training sessions, the ratio between investigators and participants was maintained at 1:4, specifically emphasizing the careful execution of leaps from a technical standpoint. The plyometric sessions ranged from 10 to 30 minutes, with variations attributed to the number of jumps performed per session and the rest period duration between sets, namely 30 seconds versus 120 seconds. All groups underwent training sessions throughout the same period of the day, specifically between 17 and 20 hours. Additionally, the rest intervals between leaps were consistent across all groups, with around 3 seconds allocated for acyclic jumps. The jump drills conducted during the training session were uniformly allocated over several surfaces, including grass, dirt, sand, and wood floors.[40] After completing six weeks of plyometric training, a post-test assessment was conducted with the subjects.

2.15. *Statistical analysis*

The data were analyzed using SPSS Version 21.0, developed by IBM-SPSS Inc. in Armonk, NY. The normality of the distribution of all variables was assessed using the Shapiro-Wilk test. The researchers employed a one-way analysis of variance (ANOVA) to compare the baseline characteristics among groups for parametric variables. At the same time, a chi-square test was utilized for non-parametric variables. The study employed repeated measures analysis of variance (ANOVA) to assess intergroup and intragroup differences. A p-value threshold of less than 0.05 was deemed statistically significant.

3. RESULTS

A total of 50 athletes were selected, and the final sample included 45 athletes with a mean age of 21.30 ± 1.65 (range 18-25 years). There were no statistically significant differences (p<0.05) in the demographic and baseline comparisons between groups (Tables 2 & 3). There were significant differences (p<0.05) found within the DT group outcomes in all the outcome measures (muscle power, speed, and muscle strength).

Table 2. Demographic characteristics of the groups*

Variable	DT Group (n=15)	KT Group (n=15)	Control Group (n=15)	*p*-value
Age, y	21.79 ± 1.63	20.87 ± 1.71	21.24 ± 1.65	0.902
Weight, kg	66.35 ± 5.73	67.94 ± 5.47	67.32 ± 5.78	0.926
Height, m	1.68 ± 0.07	1.71 ± 0.05	1.68 ± 0.05	0.901
BMI, kg/m^2	23.42 ± 1.33	23.09 ± 1.77	23.24 ± 1.56	0.769
Education, n (%)				
Graduate	14 (93)	13 (87)	14 (93)	0.892
Post-graduate	1 (7)	2 (13)	1 (7)	
Training hours in a day, n (%)				
One hour	13 (87)	13 (87)	12 (80)	0.878
Two hours	2 (13)	2 (13)	3 (20)	
Smoking, n (%)	3 (13)	2 (20)	3 (13.3)	0.827
Experience, y	4.91 ± 0.86	4.88 ± 0.87	4,89 ± 0.81	0.983
Regular exercise, n (%)	15 (100)	15 (100)	15 (100)	1.00

DT = dynamic tape, KT = kinesio tape, BMI = body mass index
Values are mean ± SD unless otherwise indicated.

Table 3. Baseline characteristics of the groups (Mean ± SD)

Variable	DT Group (n=15)	KT Group (n=15)	Control Group (n=15)	*p*-value
Power				
Vertical jump (cm)	46.87 ± 2.45	48.56 ± 2.43	47.79 ± 1.99	0.909
Standing long jump (cm)	199.56 ± 5.82	197.72 ± 5.51	193.49 ± 4.96	0.792
Single leg hop (cm)	179.58 ± 3.82	176.92 ± 3.52	177.64 ± 3.82	0.739
Speed (sec)	4.78 ± 0.22	4.89 ± 0.26	4.79 ± 0.26	0.939
Strength (kg)	46.72 ± 2.73	47.48 ± 2.72	47.83 ± 2.93	0.929

DT = dynamic tape, KT = kinesio tape

Between-group comparisons, a statistically significant difference ($p<0.05$) was found in the DT group compared with KT and control group in muscle power, speed, and muscle strength (Table 4).

Table 4. Summary of outcome measures preintervention and postintervention for the DT, KT, and Control groups (Mean ± SD)

Variables	Groups	Mean ± SD			The between-group difference in change score		
		Preintervention	Postintervention	Within-Group change score	DT vs KT Group	DT vs C Group	KT vs C Group
Power-Vertical jump (cm)	DT	46.87 ± 2.45	53.59 ± 2.84	6.72 ± 0.61 (-4.92, -3.56) *	2.94* (0.47, 5.58)	3.16 * (0.52, 5.97)	0.09 (-2.47, 3.12)
	KT	48.56 ± 2.43	50.83 ± 2.72	2.27 ± 1.35 (-1.79, -0.72)			
	C	47.79 ± 1.99	49.98 ± 2.89	2.19 ± 0.92 (-3.19, -0.32)			
Power-Standing long jump (cm)	DT	199.56 ± 5.82	206.82 ± 5.49	7.26 ± 3.12 (-5.27, -3.67) *	4.59 * (0.67, 7.53)	5.42 * (2.02, 8.24)	2.81 (-2.35, 5.09)
	KT	197.72 ± 5.51	200.54 ± 4.89	2.82 ± 0.99 (-2.96, -1.14)			
	C	193.49 ± 4.96	195.56 ± 3.89	2.07 ± 0.96 (-1.96, -0.82)			
Power-Single leg hop (cm)	DT	179.58 ± 3.82	185.24 ± 3.64	5.66 ± 2.52 (-5.96, -3.82) *	5.08 * (1.53, 6.92)	5.82 * (2.53, 7.92)	2.07 (-2.01, 5.24)
	KT	176.92 ± 3.52	179.32 ± 2.88	2.40 ± 1.21 (-3.18, -1.16)			
	C	177.64 ± 3.82	179.83 ± 3.24	2.19 ± 1.06 (-1.09, -0.14)			
Speed (sec)	DT	4.78 ± 0.22	3.69 ± 0.16	1.09 ± 0.23 (0.14, 0.52) *	-0.98 * (-0.35, -0.13)	-0.54 * (-0.23, -0.09)	-0.11 (-0.21, 0.15)
	KT	4.89 ± 0.26	4.51 ± 0.35	0.38 ± 0.11 (0.05, 0.10)			

	C	4.79 ± 0.26	4.45 ± 0.38	0.34 ± 0.09 (-0.08, 0.11)		
Strength (kg)	DT	46.72 ± 2.73	49.52 ± 3.45	2.80 ± 0.84 (-0.51, 0.32) *	0.85 * (-2.53, 2.85)	0.76 * (-1.62, 2.94)	0.38 (-1.45, 2.85)
	KT	47.48 ± 2.72	48.73 ± 2.58	1.25 ± 0.99 (-0.52, 0.36)			
	C	47.83 ± 2.93	48.91 ± 2.43	1.08 ± 0.87 (-0.24, 0.92)			

DT = dynamic tape, KT = kinesio tape, C = control
**** Significant difference: p <0.05***

4. DISCUSSION

The primary objective of this study was to assess and compare the combined effect of plyometric training in combination with DT and KT, as well as a control group, on university football players. The study evaluated the impacts on various performance indicators, including muscular power (vertical jump test, standing long jump test, and single leg hop test), speed, and muscle strength. This study represents the first investigation into the collective impact of plyometric exercise and DT on university-level football athletes. This study's hypothesis, posited that the cumulative effect would be observed in the DT group as compared to the KT group and the control group across the variables, was confirmed for all outcome variables. Football is a sport that is gaining popularity throughout different levels of society. Given the global expansion of football, competence in the sport demands the acquisition of requisite abilities.[41] The sport of football is characterized by its complex nature, as it necessitates the utilization of specialized methods and strategic tactics. The importance of explosiveness and power in the lower limbs of football players cannot be exaggerated, as the nature of the sport necessitates frequent explosive movements, and jumping prowess is regarded as a manifestation of force.[42] Extensive research has yielded compelling data supporting the notion that plyometric activities have a positive impact on enhancing muscle power. Kons et al. (2023) conducted an umbrella review encompassing systematic reviews and meta-analyses, ultimately determining that plyometric activity yields improvements in physical fitness indices.[22] A meta-analysis,[43], and systematic review,[44], extensively examined the effect of KT in quadriceps on various jumping activities. Most studies concluded that applying KT does not improve jumping performances. A single investigation supporting the application of KT was documented.[45] Therefore, the current study aimed to investigate the collective impact of plyometric exercises and taping on enhancing physical fitness parameters. The findings revealed that the combined effects of plyometric workouts and DT were more effective than KT and the control group in developing muscle power. The speed exhibited by football players has a pivotal role in determining their effectiveness as well as the overall success of their team. Football necessitates a combination of offensive and defensive strategies involving the rapid transition between attacking and defending.[12] Players must rapidly change their positions and exhibit exceptional speed throughout the game. Ramirez-Campillo et al. (2021) conducted a comprehensive systematic study to assess the impact of plyometric workouts on the sprinting capabilities of athletes. Their findings indicate that plyometric activities have a positive influence on enhancing athletes' repeated sprint performance.[46] Several studies have investigated the impact of kinesiology tape (KT) on athletes' speed performance immediately after its application. The findings of these studies have shown both positive[47] and negative outcomes[48] on the effectiveness of KT application. Therefore, we integrated the utilization of plyometric and taping techniques in order to assess the enhancements in an athlete's speed. The current study clarifies the combined effect of incorporating plyometric workouts and DT on enhancing football players' speed compared to the groups utilizing KT and the controls. Optimal sports performance necessitates the presence of muscular strength. The strength of the quadriceps muscle is crucial in football, as it significantly contributes to sprinting, jumping, and ball-kicking activities. Football training enhances the strength of both the quadriceps and hamstring muscles.[49] The findings of a systematic review and meta-analysis indicate that the implementation of plyometric training can yield a substantial improvement in the explosive strength of the lower extremities among athletes.[50] Several studies have examined the immediate impact of applying KT to the quadriceps muscle on its strength. These studies have yielded varied and inconclusive findings.[51, 52] Therefore, the current study investigated the collective impact of plyometric with DT and observed enhanced muscle strength compared to both the KT and the control groups.

5. STUDY LIMITATIONS AND FOLLOW-UP

The current study also outlines certain limitations. The omission of sham taping in this study limits the ability to compare the therapeutic effects of both DT and KT with a control group. The study exclusively included male athletes as a result of the prevailing cultural norms within the country in which it was conducted. The current study's authors recommend that future research include the placebo/sham taping group to find that the improvement is due to the added effect of DT and not the placebo effect of taping. Future research may find the effects of various PE durations with DT on sport-specific fitness performances among athletes.

6. CONCLUSION

Based on the statistical analysis, the current randomized controlled trial showed that the combined effects of plyometric exercises and DT increases muscle power, decreases time duration in speed, and increases muscle strength output more than plyometric exercise alone or with KT among university male football players. This research implies that before a significant event, coaches, trainers, and players could apply DT tape and perform plyometric exercises during training.

7. ACKNOWLEDGEMENT

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8. AUTHORS CONTRIBUTION STATEMENT

Kanagaraj Rengaramanujam: conceptualization, data collection, investigation, data analysis. Dr S. Subbiah: Supervision, Writing – review & editing. Dr. Khalid A. AlAhmari: Methodology, writing - original draft

9. CONFLICT OF INTEREST

Conflict of interest declared none.

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